Art. VII.—*Further Note on the Glacial Deposits of Bacchus Marsh.*

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[Read 8th June, 1893.]

The immediate object of the present note is to correct a mistake in our investigations of the Bacchus Marsh glacial deposits, the results of which were embodied in a paper read before this Society last year. In that paper we claimed to have shown that there were two distinct tills at Bacchus Marsh, separated by the so-called Bacchus Marsh sandstones, and that the upper of these rested on the denuded surface of the sandstone. It is to the latter point that we desire to draw attention.

Our conclusions in this respect were principally drawn from the consideration of sections at a small quarry on the Korkuperrimul Creek. We here described till overlying the sandstone, and a granite boulder over a yard in diameter together with an accumulation of smaller erratics as being jammed into the broken surface of the sandstone.

Having since traversed a good deal more ground without seeing any further evidence of such a state of things, we investigated the matter further, with the result that we now find that the supposed till overlying the denuded sandstone is really a "wash," containing striated stones, and derived in part, at least, from an outcrop of a deposit a little above the quarry. The broken sandstone is due to weathering and a certain amount of rock movement. The granite boulders lie embedded in a matrix of clay which is really intercalated with the sandstones, but looking very much at first sight as if subsequently injected. There are several thin clay bands besides this running through the sandstone, and in these bands small stones of the kinds met with in the till occur. Several we found bore glacial striæ. One of these stones was six inches in diameter. About the line of junction of the largest of these bands, both the sandstone and the clay are remarkably

contorted, and the whole are inclined besides at about thirty-five degrees E.S.E.

There can be no doubt that the clay bands containing the stones and boulders are of glacial origin, in part at least, and that the larger boulders at any rate have been transported by ice, but by floating ice or land ice? It must be said that the stratified nature of the clay bands points to floating ice as being the transporting agent. In the "pocket" containing the large granite boulder we have noted at least three varieties of granite, a boulder of gneiss, and others of quartz-rock, clay-slate, etc.

The sandstone, which is of a massive type, contains *Gangamopteris* in abundance in certain zones. It passes upwards into a bed of more or less clayey nature, indistinctly, if at all, stratified, and bearing boulders and smaller stones. One well rounded boulder of granite measured eighteen inches in diameter. This deposit is overlaid by shales, and fine-grained, argillaceous, well stratified sandstones.

Consistently with our former idea we described a mass of till occurring on the Korkuperrimul Creek, opposite Bald Hill, as being banked up against sandstone. It is really overlaid by sandstone. At the large quarry on Bald Hill the sandstones are seen to be overlaid by a bed which is very rudely, if at all, stratified, and containing small stones scattered irregularly through it. The bedding planes of the sandstones appear contorted along the line of junction, but it is possible this appearance may be due to weathering.

At another small section we described before on the creek, the till is seen underlying tumultuous looking sandstones. The latter bear a few odd stones, several of which we found to be glaciated. A good deal of faulting has taken place here.

Considering the sections exposed on the Korkuperrimul Creek in this locality, we get a succession as follows :—

(1). Till containing a great deal of rock material.

(2). Stratified clays or shales.

(3). Sandstones containing intercalated bands of clay bearing boulders.

(4). A somewhat clayey unstratified deposit, which does not seem to contain so many stones as the bottom deposit.

(5). Shales and fine-grained well stratified sandstones.

A section exposed on the Lerderderg River, about two miles above Darley, shows unstratified clay containing irregular and lenticular bands of hard coarse sandstone, associated with well stratified fine glacial clays. Striated stones and boulders are very abundant through this, and are, as a rule, exceptionally well scored. One of these boulders, a hard blue slate, is five feet six inches long, three feet six inches broad, and a depth of two feet is exposed ; the surface is well scored in a longitudinal direction, though cross striæ occur also. Several other boulders at this section are over two feet in diameter. Though stones occur in the stratified parts yet they are not nearly so abundant as in the unstratified. It is worth mentioning, as illustrating the tough and tenacious nature of the unstratified till, that a farmer resident in the locality, in course of conversation with us, remarked that he had never come across such an unsatisfactory material to work. In constructing a race he had occasion to pass through some of it, which proved very obstinate to the ordinary methods of excavation. Blasting had hardly any effect, and he said the only way to deal with it was to knock it away bit by bit with a hammer and a gad.

We traced the till on to the crest of a spur of the Lerderderg Ranges at a height of about 1000 feet above sea-level (aneroid reading). At one place on the flanks of these ranges, where we could actually see the junction of the till and the Silurian, we found the latter well scored and grooved. In the striated rock surfaces described in our last paper, the striæ and grooves were N. and S., being parallel to the strike of the rocks. In this case the direction of the striæ and grooves is W. 10° N. and E. 10° S., almost at right angles to the strike. In the former case the grooving and moulding was more marked and may be compared to grooves made by a gouge working with the grain of a piece of wood, while in the latter instance the appearance is somewhat similar to that made by a blunt gouge working across the grain

of a piece of wood of uneven texture, now working fairly smoothly, now catching in a harder band, wrenching a piece out, and again proceeding evenly. An indication of the direction of the ice can be thus obtained. In this case the ice appears to have come from ten degrees south of east, but it would be unwise to infer much from this one instance, especially as there is abundant evidence to show that the Silurian rocks have undergone considerable movement since this ancient ice-age.

Wherever we have seen the junction of the till with the Silurian, the former has always been intensely hard and unstratified, and the latter invariably grooved, smoothed, and striated. These are facts, which, in our opinion, point to one conclusion, viz., that the lowest member, at least, of the glacial series is morainic, due to the action of land ice, of the former presence of which we have unquestionable evidence in the *roches moutonnées*. It will have been seen that the Bacchus Marsh sandstones must be considered as part of the glacial series—a conclusion to which our friend, Mr. Brittlebank, has also come independently of us. As the only fossils obtained so far are plant remains, a fresh-water origin for them is indicated, and it is reasonable to suppose that these sandstones were deposited in a glacial lake in which floating ice drifted. The clay bands in the sandstone may perhaps have been formed by subglacial material carried into this lake by streams. Any floating ice would be drifted with the currents and drop their burdens occasionally in the accumulating silt. Such a lake may have been almost an inland sea. The vast size attained by glacial lakes in America during the last ice-age is well known. The alternation of boulder beds with plant-bearing sandstones is only what would be expected on the astronomical theory of ice-ages.

POSTSCRIPT.

Since reading the above paper we have discovered several beautiful examples of *roches moutonnées*, near Coimadai. The smoothed and grooved surfaces can be traced right beneath hard unstratified till. There is also good evidence to show the direction the ice took at this locality, viz., from S.S.W. to N.N.E. These are by far the best example of *roches moutonnées* we have seen in

this district. A detailed description we must leave for a future paper.

Among the fossil plant remains we have discovered in the Bacchus Marsh sandstones, what Sir F. McCoy thinks are probably *Schizoneura* are by far the most abundant. Sir Frederick has also determined the genus *Ptilophyllum*, being the first occurrence of this genus in Victoria. He has described it under the name of *P. officeri*. Several other forms are awaiting identification. They all come from the Schizoneura bed—a thin clayey band about four inches in width. The horizon is apparently above that of the *Gangamopteris* beds.

Sir F. McCoy's description of *Ptilophyllum officeri* is as follows: "Pinnæ about one inch wide; pinnules about eleven in one inch, nearly at right angles to rachis, with coarse, unequal, longitudinal striæ; width of pinnules about half a line, one line apart; rachis about one line wide."